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ENHANCED SATELLITE CLOUD ANALYSIS BY THE DEVELOPMENT OF A HIGHER RESOLUTION (6-KM) GLOBAL GEOGRAPHY DATA SET

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ABSTRACT

An improved global 6-km raster geography based on an Air Force vector product, several terrain data sets, and human interpretation has been produced at the Air Force Phillips Laboratory, Hanscom AFB, MA. Additionally, desert surface types were identified using background brightness values from satellite measurements. Use of this improved geography data has dramatically improved cloud analysis, particularly over coastal areas. This data set was produced as part of the SERCAA (Support of Environmental Requirements for Cloud Analysis and Archives) global cloud detection and analysis algorithms. These algorithms utilize the capabilities of both polar orbiting and geosynchronous satellites. Since detailed knowledge of the underlying surface is critical to the cloud/no-cloud decision process, a necessary component of the cloud analysis effort is a fine-resolution geography database that determines information on surface characteristics such as land-water boundaries, deserts, and lakes. Such geographical data has also been used to retrieve surface skin temperatures, thus further increasing the accuracy of the thermal infrared section of the cloud detection algorithm.

1. INTRODUCTION

Under the Support of Environmental Requirements for Cloud Analysis and Archives (SERCAA) project, the Air Force Phillips Laboratory has developed global cloud analysis algorithms that utilize the capabilities of both polar orbiting and geosynchronous satellites.[1] During algorithm development, a detailed knowledge of the underlying surface was found to be more critical to the cloud/no-cloud decision process than originally anticipated. The production of a higher-resolution geography database that better delineated both ocean and lake coastlines, and defined deserts, became a necessary component of the cloud analysis effort. The resulting 6-km global geography is based on the vector coastlines currently used at Air Force Global Weather Central (AFGWC), Offut AFB, NE, Defense Mapping Agency (DMA) Digital Terrain Elevation Data (DTED) based sea-level heights, and extensive human interpretation. Desert surface types were identified using background brightness values from satellite measurements. These enhanced geography data sets have dramatically improved cloud analysis, particularly over coastal areas.

The Earth Observing System (EOS) Moderate Resolution Imaging Spectroradiometer (MODIS)

science team is also making use of SERCAA algorithms in its work with cloud masking algorithms. This group has found that the use of even higher-resolution land/water masks further improves cloud analyses.[2] They are using a new 1-km land/water data set developed by the United States Geological Survey (USGS) Earth Resources Observation Systems (EROS) Data Center that is based on the rasterized Digital Chart of the World (DCW) and World Vector Shoreline (WVS) data sets.[3]

2. DATA SOURCES

The 6-km geography data set is based on a rasterized version of the vector coastline data set currently in use at AFGWC. For the northern-hemisphere, these data were merged with sea-level (zero elevation) contour data from a 6-km terrain data set based primarily on DMA 3-arc-second data.[4] Extensive human interaction refined this product generating an accurate 6-km geography raster data set, complete with large inland lakes. Since very little DMA DTED data were available for the southern-hemisphere, the data set relied alone on the AFGWC data and once again on detailed human interpretation. In addition, locations of deserts and coastal deserts in both hemispheres were identified and cataloged from satellite background brightness values. Both the northern and southern hemisphere sets were mapped to a 6-km hemispheric standard polar stereographic projection true at 60 degrees latitude, as used under SERCAA.

3. CLOUD ANALYSIS ENHANCEMENTS

SERCAA cloud analysis products are provided at 24-km resolution, but the actual cloud/no-cloud decisions are made on a pixel-by-pixel basis. When processing all of the timely satellite data available for a location, different cloud detection algorithms are selected for use depending on whether the pixel is located over land, water, shorelines, or desert. Originally, the use of a supporting geography database with a resolution similar to that of the cloud analysis products (such as the Navy 10-minute data set) was thought to be sufficient to select the appropriate cloud detection algorithm. However, there were difficulties, particularly in geographic transition regions such as coastlines, where either obvious cloud went undetected or spurious cloud was added to the analysis. By using the new 6-km geography database, these problems were minimized. Furthermore, by using the geography data sets to enhance other crucial supporting data, such as the 48-km resolution surface skin temperatures used by the thermal infrared cloud detection algorithms, the geographic information also improved results indirectly.

4. RESULTS

In Figure 1, a DMSP OLS visible image contains a thick cloud bank over the islands of Japan. In Figure 2, the land/ocean boundaries of the region are depicted, at both 10-minute (black) and 6-km resolution (white). Using the coarser-resolution data set, several regions along the coast are incorrectly identified as boxy clouds (Figure 3). This effect is considerably lessened when the finer 6-km resolution geography is used (Figure 4). This example of a SERCAA cloud analysis over Japan demonstrates the improvement in cloud detection that occurs due to the implementation of finer-resolution geography databases.

5. CONCLUSIONS

Higher-resolution background geography data sets are a necessary component of satellite cloud analysis. A 6-km global geography raster data set has been constructed at the Air Force Phillips Laboratory in support of the SERCAA cloud analysis project. Since the SERCAA algorithms have

been chosen as part of the current Cloud Depiction and Forecast System II (CDFS II) procurement at AFGWC, this geography data set will be used operationally. As the EOS remote sensing instruments go on-line, and as higher resolution mapping data are being made available, even higher-resolution data sets are being produced. Some of these, such as the 1-km land/water raster data set recently produced by USGS, have been implemented with SERCAA based algorithms and shown sufficient improvements to warrant further evaluation.

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